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Saint Nicholas of Myra. Cataloguing, Identification, and Recognition Through AI

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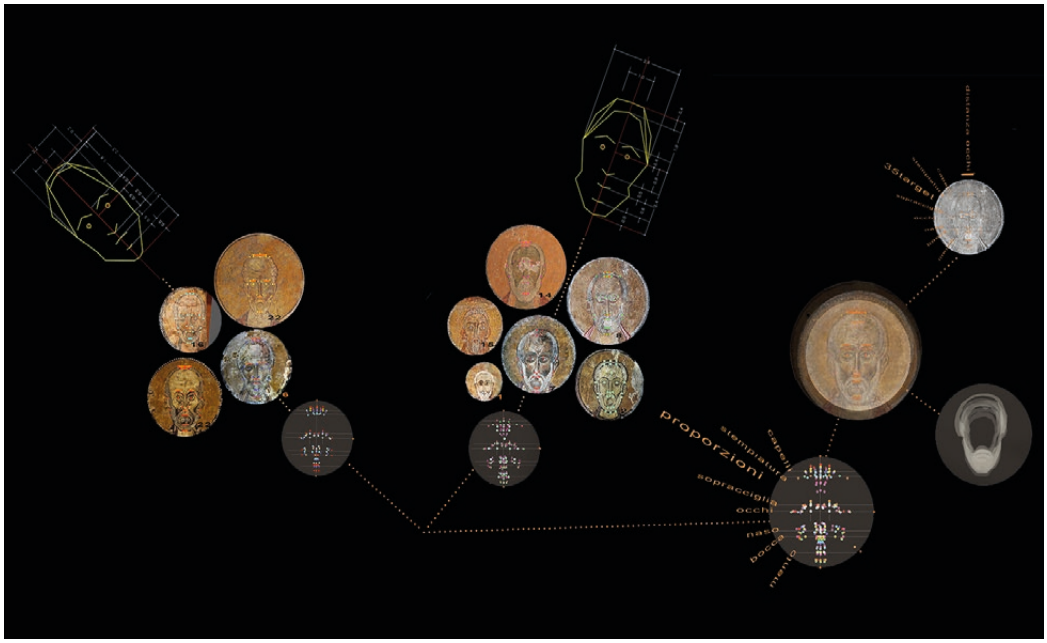
Abstract

This research elaborates a strategy to guide users and scholars in the Byzantine iconographic world, highlighting the elements that contribute to recognizing the sacred figures represented [2]. It develops two visual approaches: on the one hand, the recognition of faces through a database; on the other hand, the use of artificial intelligence for face recognition. The results of the research can be applied to the development of content for new media edutainment; for the digital restoration of the frescoes; for the communication and enhancement of the asset itself.

Keywords
AI, iconography, Byzantine, Saint Nicholas of Myra.



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Research Protocol

Byzantine iconography is an extremely complex phenomenon [3] for both the syncretism of different cultures and the rigid rules underlying the production of sacred images. The historical events that accompanied the expansion of the Byzantine culture in the Mediterranean area, the repeated Arab invasions, and the transition from the Eastern to the Latin rite have compromised the morphology of sacred architecture and their iconographic apparatus. The rock architectures are directly linked to the migration of monks who, under the influence of iconoclastic struggles and repeated Arab invasions, sought shelter by migrating from the East, Cappadocia, to the West, southern Italy and eastern Greece (fig. 1).
For obvious reasons, the rock churches are isolated, difficult to reach, and often abandoned.

Fig. 1. Rock churches of the oriental rite. Localization of surveyed case studies and formal references.

Fig. 2. St. Nicholas of Nazianzen. Identification system based on an iconographic database.

The resulting disuse, paradoxically, preserved them by excluding from continuous adjustments to the changing needs of the cult and society. At the same time, the abandonment, together with numerous deliberate damages of the iconoclastic era, compromised the legibility of the iconographic apparatus. The proposed system guides users into the Byzantine iconographic world, highlighting the elements that help recognize the represented sacred figures. This system can be developed in two different ways: by recognizing faces already presents in a database or by using artificial intelligence to recognize faces and virtually restoring them (fig. 2). In the first mode, the system identifies the representation of the Saint, offering a comparison with other images present in the neighbouring regions and highlighting recurring elements [4]. Moreover, the system underlines the elements that contribute to the identification of the saint himself [Grotowski 2010; Innemée 1992].

The second mode, which uses AI to analyse the morphology of the face of St. Nicholas of Myra, is useful for recognition and virtual restoration [Maronidis 2014].
Four phases describe the research strategy: 1) definition of the survey field; 2) choice of the case study; 3) definition of the AI workflow; 4) application of the obtained results to recognition and reality enhancement.
The field of investigation is divided into two parts. In the former, the architectures that can be part of a circuit of rock churches that are homogeneous in terms of dating, geographical location, iconographic apparatus and analyses carried out. These churches date between the ninth and fourteenth centuries and belong to the ancient Thema of Sikelia, (transformed after the Arab conquest into Thema of Calabria) to the Thema of Langobardia (the current Puglia), and to the Thema of Hellas, in Thessaly. In the latter part, the need to broaden the survey base and give strength and structure to the automated AI process leads us to include the iconographic apparatus of many other architectures, which belong to the southern part of the Mediterranean, and homogeneous to the first ones for dating [5].
The case study is the effigy of St. Nicholas of Myra, widespread throughout the south. The effigy of the Saint appears very repetitive and codified. For this reason, this effigy is suitable for an analytical investigation that starts from some preliminary morphological hypotheses.

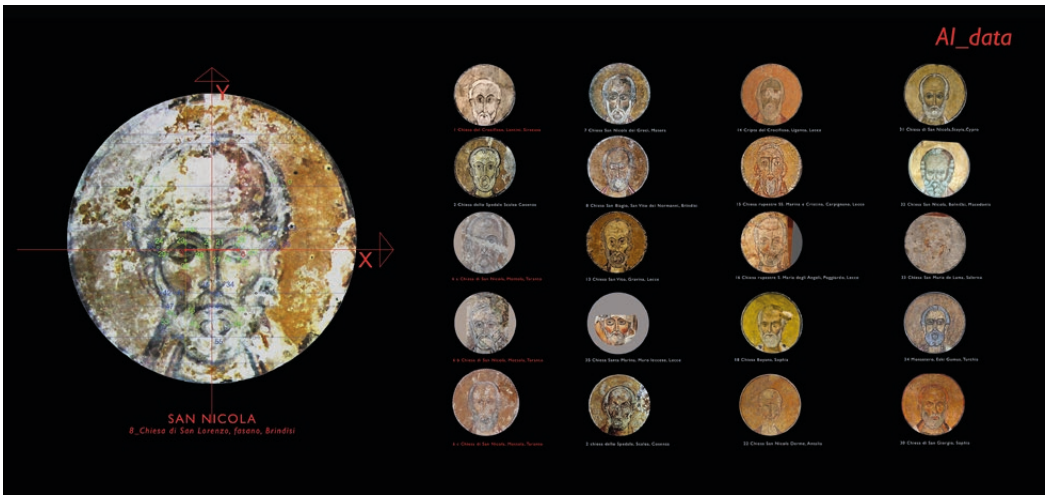

Fig. 3. AI, input data of the reference models.

AI Workflow

The artificial–intelligence–based technique used to analyse the effigies of Saint Nicholas has been implemented in Python and exploits the Scikit–learn library [https://scikit-learn.org/]. The considered input is the set of 19 images of Saint Nicholas reported in fig. 3. The workflow involves three phases.
1. In the first phase, the model input was generated. To identify the position of each point on the face, a reference system with abscissas and ordinates was used that marks the vertical symmetry axis of the face and centres the distance between the pupils. This distance is constant in all images and makes a proportional comparison between the selected images. For each image, the positions of 50 specific points of the face have been identified and measured in the two–dimensional Cartesian coordinate system.
Specifically, we show in fig. 3 the points selected in the face are marked by three different colours. We mark in blue the points related to the proportions of the face, such as face width and height, eye position, nose, and mouth. Green is used for the points related to the morphology of the somatic features, such as the shape of eyes, mouth, and beard. Finally, the points that cannot be detected on a single face are marked in black.
2. In the second phase, missing data have been replaced by the mean of the column, and obtained data have been normalized into the range 0 and 1.
3. In the third phase, we used the k–means clustering method to partition the images into

several groups in such a way that images with similar characteristics belong to the same group. We varied the number k of clusters, and the results of these analyses are discussed in the next section.

Conclusion

We performed several analyses varying k (i.e., the number of clusters). For space limitations, we report the results of the most interesting experiment with k=3. The three clusters show differences in the face size and lip crease and do not seem to identify a partitioning related to the painting dating or the geographical location (fig. 4). in a further analysis, we overlapped the images in the same cluster and tried to 'visualize' the distinctive features of the faces. The division into clusters becomes more precise and a differentiation emerges: the reduced size of the forehead (cluster 2) or the size of the beard and chin and the more pronounced fold of the lip downwards (cluster 1). Cluster 0 shows intermediate features.
The experimentation is only at the beginning, and we expect that with the introduction of other data and the collaboration of an Iconographer, it will also be possible to obtain a reliable hypothesis for the reconstruction of the missing parts (fig. 5).
The model obtained with AI made it is possible to identify some preliminary strategies for the morphological classification of the iconography of St. Nicholas through the identification of the complex proportional relationships between the parts of the face. The results of the recognition and cataloguing carried out by artificial intelligence can be applied to: creation of implementable databases for the dissemination and documentation of the Byzantine iconographic heritage; development of content for new media related to edutainment; digital restoration of the asset; communication of the asset aimed at the enhancement and consequent conservation of the asset itself.

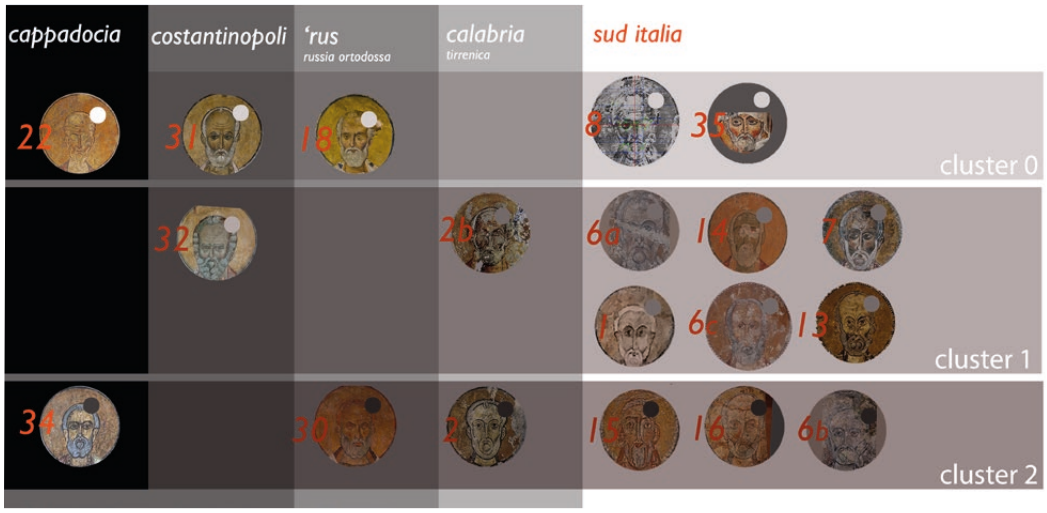

Fig. 4. AI clustering results.

Fig. 5. AI clustering: visualization of the data obtained.

Notes

[1] The research presented in this paper is the result of the joint work of the two authors. The Research Protocol is created by Marinella Arena, the AI Workflow is in the name of Gianluca Lax, the Conclusion is jointly signed.

[2] IThis study is part of a wider research, between Ionio and Egeo conducted with Daniele Colistra and Domenico Mediati, which has surveyed many sacred buildings of the Byzantine era.

[3] "at the actual stadium of our knowledge we are not able to establish links between the saved pieces of art and the social structure or the byzantine geography (...) some general facts reaffirm this pessimistic attitude: the systemic anonymity of the byzantine pieces of art, the extreme lack of the written sources, caused by the disruption of almost all the archives; in the end the insufficient differentiation between the pieces of art." [Grabar 1964, pp. 27-28].

[4] Just as in language few signs, combined differently, generate a multitude of words, similarly in Byzantine sacred representations the sacred vestments, the nimbus, the homophorus, the polistavrion, or the receding hairline, the colour of the hair, or the shape of the beard, identify the Saint's figure. Cfr: "Pursuing the 'representation' rather than the 'imitation', Byzantine artists used a limited range of forms. Within these stylistic norms they changed the physical appearance by modelling the shape of the head and the outline of the cheeks. They used lighter or darker pigments to achieve different skin tones. A wider colour and variety of form was possible in depicting hair and beard. They could be dark, red or white, long or short, whereas the absence of beard and moustache was meant to suggest young age. This method allowed the creation of a very limited number of face–types. This is confirmed by monotonous descriptions in iconographic manuals and eikonismos collections." [Grotowski 2010, pp. 137-138].

[5]. Geographical and chronological location of the case studies: 1_Chiesa del Crocifisso Lentini, Siracusa, 1000; 2_Chiesa dello Spedale, Scalea, Cosenza, 1000; 2b_Chiesa dello Spedale, Scalea Cosenza, 1000; 6 a_ San Nicola Mottola, Taranto, 1100; 6 b _San Nicola Mottola, Taranto, 1300; 6 c _ San Nicola, Mottola, Taranto, 1300; 7 _ San Nicola dei Greci, Matera, 1200; 8_ San Lorenzo, Fasano, Brindisi, 1200; 13_ San Vito Gravina, Lecce, 1300; 14_ Cripta del Crocifisso, Ugento, Lecce, 1350; 15_ SS. Marina e Cristina, Carpignano, Lecce, 959; 16_ S. Maria degli Angeli, Poggiardo, Lecce, 1200; 18_ Chiesa Boyana, Sophia, 1250; 22_ San Nicola, Derme, Antalia, 800; 30_San Giorgio, Sophia, 1250; 31_ San Nicola, Steyis, Cypro, 1100; 32_ San Nicola Bolnicki, Macedonia 1350; 34_ Monastero Eski Gumus, Turchia 1000; 35_ S. Marina, Muro Leccese, Lecce, 1087

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